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ABSTRACT

This paper presents the procedures, findings, and conclusions of a study designed to determine the effects of a modified elementary science education methods course on students' creative thinking, self evaluation, and achievement. While lecture-discussions were essentially the same for both experimental and control groups, the laboratory sessions and written assignments were different. In the experimental group laboratory, creativity-training activities including (1) brainstorming, (2) inquiry development, (3) morphological analysis of problems, and (4) invitation to creative thinking were used. Pretest and posttest scores of fluency, flexibility, originality of idea production, and achievement were gathered for both groups. Two researcher-constructed instruments to provide data on students' ratings of (1) their achievement and (2) the course were administered. The experimental group was found superior to the control group in gains in fluency, flexibility, and originality. No difference was found between groups in achievement scores. There were no significant differences between groups in self-ratings of achievement of cognitive course objectives. The findings suggest that creativity can be improved. (LC)

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THE EFFECTS OF SELECTED TEACHING METHODS ON CREATIVE THINKING, SELF-EVALUATION, AND ACHIEVEMENT OF STUDENTS ENROLLED IN AN ELEMENTARY SCIENCE EDUCATION METHODS COURSE

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Theoretical Basis for the Study

Guilford[1], in his classic article dealing with the human intellect, proposed a theoretical model representing the structure of intellect (see Figure 1). The Model was developed through a series of studies using factor analytic methodology. Parameters of Guilford's theoretical structure include the operations of thinking, the content with which operations are performed, and products of thought resulting from the interaction of operations and content.

For this study, the most important dimension is the operations parameter, consisting of cognition, memory, divergent production, covergent production, and evaluation.

Cognition comprises recognition, comprehension, and understanding of information. Memory involves the storage and retention of knowledge. Creativity is represented in the Model by divegent thinking, including such factors as fluency, flexibility, and originality of idea production. In divergent idea production, the individual is free to generate independently his own data within a data-poor situation, or to take a new direction or perspective on a given topic. Mental searches for many possible solutions to problems and movement in new and untested directions also characterize the divergent production operation. Convergent production consists of analysis and integration of given or remembered data. It characteristically leads to an expected or conventional endresult due to the tightly-structured framework within which the individual must respond. Evaluation includes operations determining the goodness, adequacy, or desirability of some idea or action.

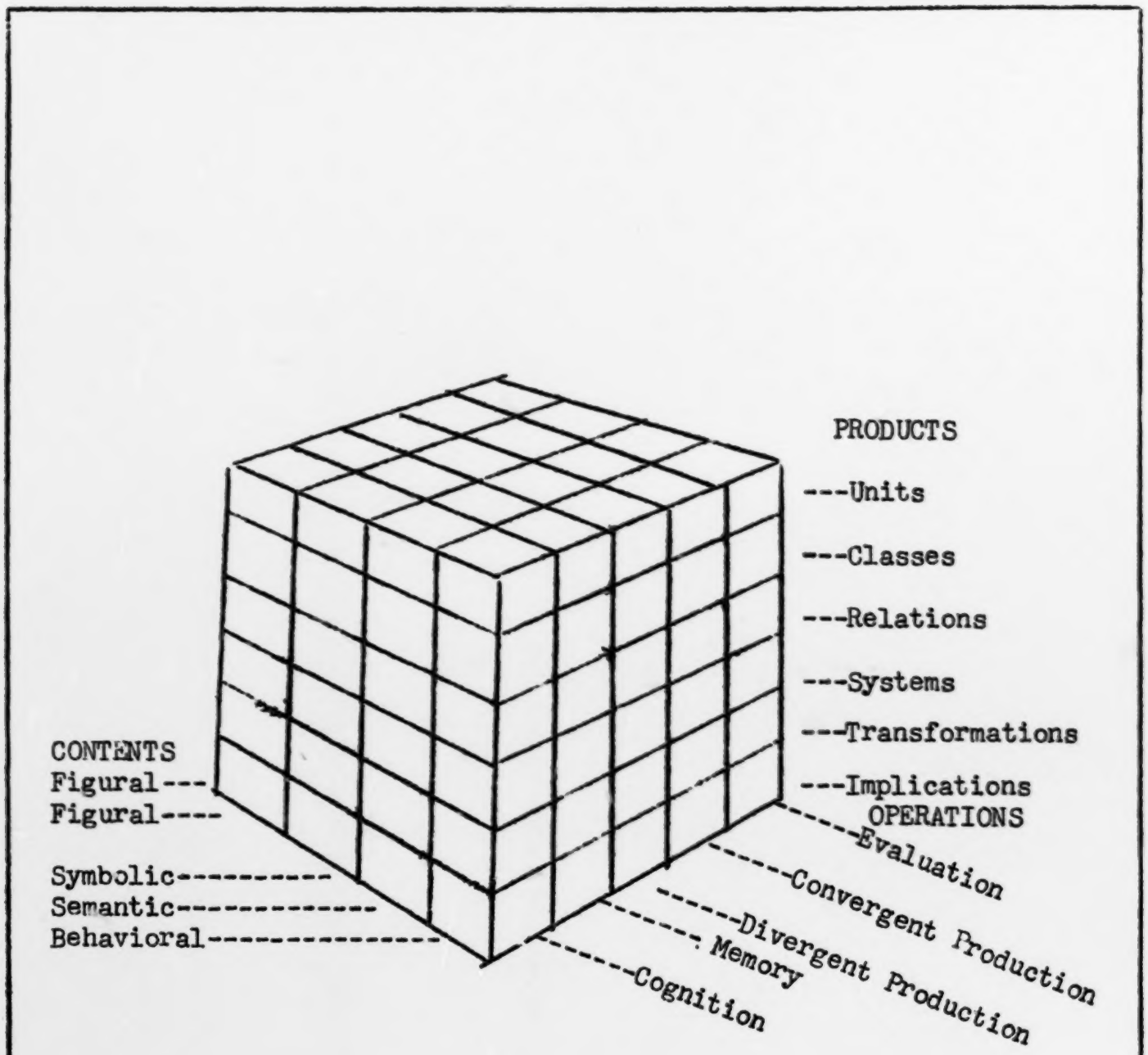

Figure 1. Guilford's Structure of Intellect Model

The Structure of Intellect Model is especially useful as a source of implications for the learning and teaching of creative thinking. Three implications have been suggested by Gowan.[2]

1. The divergent production category reflects a whole constellation of specific factors capable of stimulation through classroom experiences. Thus, creativity can be operationally cosidered as consisting of specific behaviors such as "ideational fluency" (listing attributes of objects fitting broad classes), "flexibility" (lising uncommon uses for a brick), and "orriginality" (constructing models useful in explaining a perceived event).

2. There appears to be a heirarchy of cognitive abilities in terms of their capacity to withstand stress and anxiety. Simple operations are much more stable than more complex categories. Thus, stress and anxiety militate against divergent idea production.

3. The formulations of Guilford and related experimentation by others have shown rather clearly that creativity is necessary even for conventional achievement. What school counselors have attempted to treat as "low-motivation" or "under achievement" may actually be a deficiency in creativity.

Also using Guilford's Model as a theoretical base, Torrance[3] has designated seven creative thinking abilities in the divergent production category. These include: "ideational fluency, flexibility, originality, inventiveness, constructiveness, constructiveness, ability to ask questions, and ability to formulate hypotheses about consequences." To encourage the development of these abilities in children, Torance suggests the following five principles:

1. Be respectful of unusual questions;

2. Be respectful of unusual ideas of children;

3. Show children that their ideas have value;

4. Provide opportunities for self-initiated learning; and,

5. Provide for periods for non-evaluated practice of learning.

Studies conducted by Torrance[4] and others have contributed an enlarging body of evidence indicating creative thinking performance of both children and adults can be improved.

The present study has been an attempt at determining the effects on prospective elementary teachers of a science methods course modified to encourage improved student abilities in the "divergent production" parameter of Guilford's Model. Torrance's implications for teaching, based on the Model, have been used as guidelines in the selection and implementation of the teaching methods used in the modified course.

Method of Study

This investigation has explored the effects of a modified elementary science education methods course on students' creative thinking, self-evaluation and achievement. Thirty juniors and seniors enrolled in Science Education 270 at Colorado State College for the Winter Quarter 1969, comprised the experimental group for the study. Thirty-nine students enrolled in another section of the course were involved as a control group.

Lecture-discussion meetings were essentially the same for both groups. Laboratory sessions and related written assignments, however, varied. Control group laboratory sessions were organized around the standard course laboratory manual and related researcher-constructed

Laboratory Supplements. Experimental group laboratory sessions were concerned with the same science topics, but certain creativity-training activities were also included. These were:

1. Brainstorming. (According to Osborn[5]) As it is usually conducted, this technique involves group thinking regarding a problem. All criticism of ideas is strictly prohibited, and participants are encouraged to suggest any idea, no matter how ridiculous it might sound. Evaluation of the ideas comes at a later session. It is thought that this technique stimulates the fluency, flexibility, and originality phases of Guilford's divergent production operation.

2. Inquiry Development Sessions. (According to Suchman[6]) These sessions are specially structured class discussions. They usually begin with a demonstration of some discrepant event designed to perplex the students. Students try to find an explanation of the episode by gathering information through question-asking. They are not permitted to ask for explanations, but can ask for as much data as they like. It is believed that this technique results in increased student divergent production abilities of formulating questions and constructing hypotheses.

3. Morphological Analysis of Problems. (According to Zwicky[7]) This technique utilizes a chart to "force relationships" which may result in original solutions to problems. It is assumed that the use of the technique encourages appreciation of highly original problem solutions, and also provides practice in the fluency and flexibility aspects of divergent production.

4. Invitations to Creative Thinking. There are researcher-developed "take-home" written exercises, providing students with individual divergent thinking experiences through brainstorming, inquiry exercises, and morphological analysis.

Pre-test and post-test scores of fluency, flexibility, and originality of idea production were gathered for both groups through administration of the Torrance Tests of Creative Thinking (TTCT). Pre-test and post-test achievement scores were determined through administration of the Science Education Achievement Test (SEAT), modified by the researcher from a test developed by Tillery.[8] Analysis of covariance was used to determine whether significant differences in fluency, flexibility, originality, and achievement accurred from pre-test to post-test between the groups.

Two researcher-constructed instruments were administered at the conclusion of the course: The Self-Evaluation Inventory (SEI), providing data regarding students' ratings of their achievement of the forty-seven cognitive and eleven affective behavioral objectives specified for the course; and, the Course Evaluation Instrument (CEI), providing data on students' ratings of various portions of the course. A t-test was used to determine any differences between group ratings of each of the SEI and CEI items.

The Pearson product-moment statistic was used to determine any correlation between the TTCT and SEAT post-test scores.

Findings

The experimental group was found superior to the control group in gains in fluency, flexibility, and originality TTCT

scores at a highly significant level. No difference was found between groups in SEAT scores. The SEI data indicated essentially no differences between groups in self-ratings of achievement of cognitive course objectives, but the experimental group was significantly higher in ratings of affective objectives. In CEI ratings of twelve components of the methods course, no differences were found for ten of the items, while lecture-discussion sessions were rated significantly higher by experimental subjects, and a test-construction assignment was rated significantly higher by control subjects. A significant negative correlation was found between TTCT and SEAT post-test scores.

Implications

The findings of this study substantiate previous investigations indicating creativity can be improved. Entire courses in creativity-training, however, seem unnecessary. It appears creativity-training may be included as a portion of an existing elementary methods course and effect gratifying creativity improvement with no loss in subject-matter achievement. Coupled with this, the significant affective gains found associated with the inclusion of creativity-training in a modified methods course suggest methods courses could be improved by including creativity-training as a regular course of action. Some relationship may be operative between students' improved creativity and affective gains. A possible hypothesis as to the nature of this relationship is that the degree a person utilizes his creative abilities may be a function of his affective disposition toward these abilities. In other words, creativity-training may affect very little the actual

ability of a person to be creative. Creativity-training, through stimulation and reinforcement, may have much more impact on the attitudes and values of the subject regarding creativity. It would follow, then, that the creativity-trained person becomes more creative because he values creativity more than he did before training.

One possible implication of the above hypothesis is that Guilford's Structure of Intellect Model can be modified. The Model could be extended to include an affective matrix enveloping the entire intellect. As shown in Figure 2, this matrix can be imagined as a dynamic thing, surging high and low at varying points in response to fluctuations and accumulations of stimulating and reinforcing factors of the environment. If the thickness of the affective layer correlates positively with the degree of stimulation and reinforcement of the cognitive factors it envelops, it is likely the girth of the matrix surrounding various parameters would vary considerably. Education has traditionally emphasized the cognition, memory, and convergent production thought operations far more than the divergent production and evaluation operations. As shown in Figure 3, it is likely that the affective matrix for a person untrained in creativity is especially thin in the divergent production area. If performance is strongly influenced by the affective matrix, a reason for the mediocre creativity performance of so many students is apparent. They do not value creativity, or desire to be creative. It may be that creativity training provides this desire, thickening the affective matrix in the divergent production area.

The significant negative correlation between creativity and achievement test scores found in this study suggests the highly creative methods course student may be discriminated against by standard subject-matter evaluation instrument orientation. Probably evaluation instruments should involve higher levels of thought, including creativity.

As a corollary to this investigation, specification of cognitive and affective behavioral objectives, and the application of these in student self-evaluation has been a promising technique.

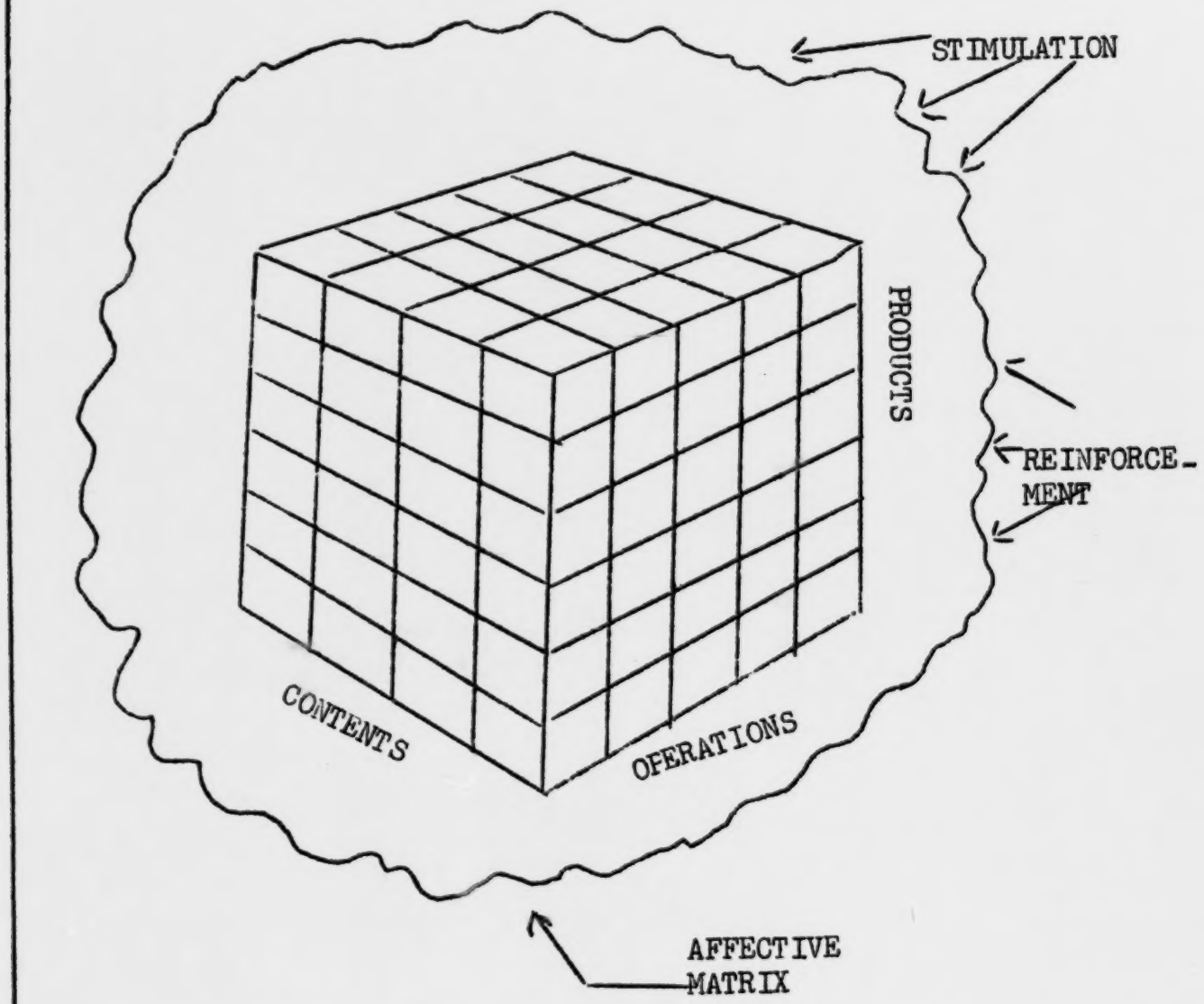

Figure 2. A Modification of Guilford's Structure of Intellect Models

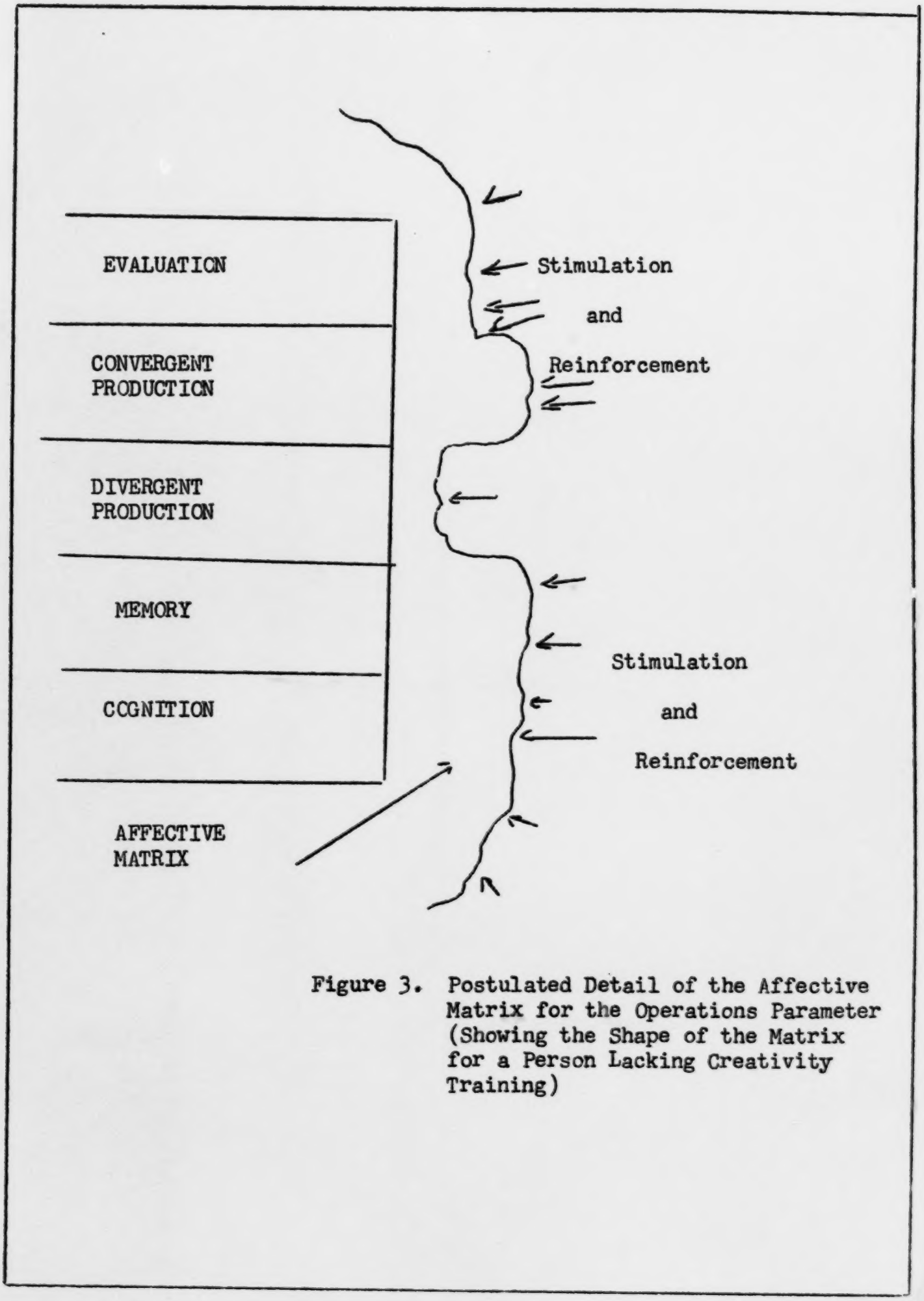

Figure 3. Postulated Detail of the Affective Matrix for the Operations Parameter (Showing the Shape of the Matrix for a Person Lacking Creativity Training)

References

1. J.P. Guilford, "Three Faces of Intellect," American Psychologist, XIV (Winter, 1959), 469-79.

2. John C. Gowan, "Some Newer Theoretical Implications for Creative Learning," Gifted Child Quarterly, IX (Spring, 1965), 7-8.

4. Ibid.

5. Alex F. Osborn, Applied Imagination (New York: Charles Scribners' Sons, 1953).

6. J. Richard Suchman, "Inquiry Training: Building Skills for Autonomous Discovery," Merrill-Palmer Quarterly, VII (July, 1961), 147-69.

7. Fritz Zwicky, "Morphological Analysis," cited in Sidney J. Parnes and Harold F. Harding, A Sourcebook for Creative Thinking, (New York: Charles Scribners' Sons, 1962), p. 255.

8. Bill W. Tillery, "Student Achievement, Self-Evaluation and Performance in a Science Education Course for Prospective Elementary Teachers" (unpublished doctoral dissertation, Colorado State College, 1967).